Beyond the 'net neutrality' debate: Price and quality discrimination in next generation internet access

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Abstract

This paper is a technical regulatory analysis of Next Generation Network (NGN) access for consumers to internet content, to be read by those familiar with regulatory law and economics concepts, and the broad outline of the debate within telecoms regulation. The problem is defined and the analysis explained in Section 1. Section 2 develops an economic analysis of discrimination among content types. Section 3 analyzes the scope for command-and-control or co-operative regulatory intervention. This takes into account issue linkage (including regulatory capture by both carriage and content provider incumbents and regulatory delay) and the available policy instruments, in the European and international context. Next Generation Networks (NGNs) present enhanced opportunities to offer internet content to consumers. They can be defined as networks with a packet-based architecture, facilitating provision of existing and new services through a loosely coupled, open and converged communications infrastructure. Access to NGNs offers the potential for abusive discrimination. Abuse is usually characterised in telecoms as a monopoly problem: where one or two Internet Service Providers (ISPs) have dominance – typically in the "last mile" of end-user access. ISPs can impose discriminatory treatment on all content or, where they are vertically integrated, on particular content against which they compete with (for example, Voice Over IP [VOIP], as in *Madison County*)[1]. The suggestion is therefore that the problem can be resolved by introducing greater competition or closely policing conditions for vertically integrated services, such as VOIP.

Our approach neither proposes an absolute ban on price discrimination nor an absolute prohibition on regulatory oversight. Instead it begins by asking which potential abuses define the problem in its European manifestation. The issue, broadly put, is whether ISPs are motivated to provide incentives to content providers to pay for superior service via either:

- lower levels of service for the same price (e.g. blocking or "throttling" content)
- higher price for higher Quality of Service (QoS).

This can take place even where an ISP does not have dominance (expressed in European debate as Significant Market Power [SMP][2]). Certain types of Peer to Peer (P2P) traffic are highly valued by end-users and are potentially discriminated against in whole or in part by non-

[1] Madison River Communications, LLC, Order, DA 05-543, 20 FCC Rcd 4295 (2005), available at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-05-543A1.pdf

[2] See the European Commission guidelines: http://ec.europa.eu/comm/competition/liberalization/others/i02_1016_en.pdf

dominant ISPs. They have socially-beneficial competitive and traffic-management reasons to do so – it makes their networks safer and more efficient. It is thus hard to determine whether their discrimination has less-benevolent motives or consequences, like blocking competition. Many assertions are made about the impacts of certain types of traffic, but regulators have no basis for deciding whether they represent big or small problems. ISPs' assertions that P2P traffic contains a high proportion of malware may be disingenuous. Email spam and web surfing are vectors for malware, but ISPs don't block such traffic. A research base in monitoring Internet traffic and usage would help the regulator to understand the importance of such stakeholder claims.

NGN access to content in Europe has been dismissed as an American debate caused by a lack of competition to the reintegrated AT&T and Verizon and to cable companies. We suggest that this debate does have serious implications for Europe. The extreme positions taken in the US debate cloud interesting questions about the benefits and costs of discrimination in faster and higher quality internet content services. Europe is not different, for two reasons. First, competition among ISPs in some metropolitan and suburban networks is limited by both geographical scale and feature-price scope. Second, as identified above, there can be motives to "throttle" content such as P2P no matter what the competitive position of an ISP. This could ultimately jeopardise the rise of Web2.0 content services – and thus user content generation - in Europe. SMP operators primarily want to ensure they have (and their rivals lack) the resources to innovate. To a lesser extent, they may want to encourage stakeholders on whom they depend to innovate (e.g., SMP content providers such as broadcasters may want to encourage innovation on the part of a network operator to enable a required new service to effectively deliver content). However, many European citizens will want to use P2P services to share user-generated content. A "universal service obligation" that is upgraded as broadband network speeds increase can ensure a minimal open internet layer is maintained.

The argument about who should pay for the significant extra investment required for advanced "next generation" internet infrastructure continues; thus far, the suggestion is that network or content providers (but not end-users or government tax incentives) should do so. The research behind this paper developed scenarios that offer alternative paths for a wide range of stakeholders to invest and benefit from each others' investment. It is vital to elaborate more closely the costs and benefits of different relationships between content and carriage. For example, it is still unclear whether "broadcast TV on the internet" or an unrestricted P2P model is more attractive to investors, users and public welfare. Regulators and policymakers could devote more attention to the evidence base for modelling those choices (Broadband Stakeholder Group, 2007).

The economic analysis first developed a process map of the content distribution system, taking into account both the layered structure of the telecommunications and the extended, non-linear "value mesh" linking key players. This approach considered vertical and horizontal integration, bundling of content and services and changes from client-server to user-generated business and societal value models. It also highlighted the potential importance of alternative (e.g. mobile and other wireless) channels. Market structure, conduct and performance aspects of the current state of play were assessed on the basis of published sources and peer-reviewed literature in order to highlight the demonstrable extent of market failure, significant trends and key (present and future) uncertainties. This was followed by analysis of potential changes in market alignment in response to exogenous (e.g. technological) shocks and trends and as a manifestation of endogenous (e.g. competitive and self-regulatory) forces. We explain this in detail in Section 2.

Section 3 analyzes the scope for intervention by command-and-control or co-regulatory means. This takes account of issue linkage (including regulatory capture by carriage and content provider incumbents and regulatory delay) and available policy instruments, in the European and international context. An open content model tends towards 'Web2.0'-type "public good" value

and innovation concentrated in end-users rather than in network operators and associated clusters of developers. While this is by no means the only model for internet-based and ICT-oriented innovation, it is a promising approach. Current choices about regulation of these sectors can affect this business model choice and therefore end-user benefits. This analysis supports a light-touch regulatory regime involving reporting requirements and co-regulation, with as far as is possible, market-based, low-cost solutions.

Because market and regulatory development are dynamically linked and far from linear, heavy regulation not only distorts market development but suppresses signals about key aspects of that development. For that reason, regulation to ensure any form of NGN access to internet content in Europe should be carried out with as light a touch as possible while maintaining effective oversight based on two modalities:

1. Regulation of information to require service providers to inform consumers about the choices they are making when they sign up for a service; and
2. Intervention to correct harmful and unjustified discrimination, which must be timely and evidence-based.

These two regulatory modalities imply a reporting burden on service providers to provide transparency in their traffic-management practices. Regulatory monitoring of potential abuses, including strengthening investigatory capacity and transparency for end-users, maintains maximum flexibility and policy choice while ensuring that abuses or unforeseen consequences can be quickly detected and dealt with appropriately. This reporting requirement could be provided in a co-regulatory forum. The European Commission as well as Member States will need to closely monitor developments in this area, especially in view of encouraging innovation and end-user access policies for “ContentOnline” and the wider Lisbon Agenda goals. Dangers of fragmentation and regulatory arbitrage may arise for two reasons: a type of “regulatory holiday” for ISPs in one country but not in another is quite likely; and enforcement of NGN access to content may be highly divergent even under the current 2002 framework. Solutions may be international as well as local, and international coordination of best practice and knowledge through fora such as the European Regulators Group and OECD will enable national regulators to keep up with the technology “arms race”.

Contents

CHAPTER 1 Net neutrality: the European debate

Section 1 asks whether Internet Service Providers (ISPs) are motivated to offer incentives to content providers to pay for superior service via lower levels of service for the same price (e.g. blocking or "throttling" content) or higher price for higher QoS. The research approach also asks whether abusive discrimination can take place even where an ISP does not have dominance (expressed in European debate as Significant Market Power [SMP][3]). We provide a policy review, including issues of:

- supply: Quality of Service (QoS) for the Next Generation Networks (NGNs) being developed; and
- user demand: the issue of user-generated ('Web2.0') content provision and how it affects investment in infrastructure.

We go on to consider market developments and policy responses in Europe and the United States. In Section 2 we analyze economic imperatives to discriminate; and in Section 3 offer conclusions and regulatory recommendations.

1.1 NGNs and consumer access to content

NGNs present enhanced opportunities for offering internet content to consumers. By internet content, we refer to content provided to the general consumer on the public internet[4], as opposed to private networks. As the Organisation for Economic Cooperation and Development (OECD) states:

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[3] See the European Commission guidelines: http://ec.europa.eu/comm/competition/liberalization/others/i02_1016_en.pdf

[4] See Trope (2005): "The Internet is a vast network of individual computers and computer networks that communicate with each other using the same communications language, Transmission Control Protocol/Internet Protocol (TCP/IP). The Internet consists of computers around the world using TCP/IP protocols. Along with the development of TCP/IP, the open network architecture of the Internet has the following characteristics or parameters: 1. Each distinct network stands on its own with its own specific environment and user requirements, notwithstanding the use of TCP/IP to connect to other parts of the Internet. Communications are not directed in a unilateral fashion. Rather, communications are routed throughout the Internet on a best efforts basis in which some packets of information may go through one series of computer networks and other packets of information go through a different permutation or combination of computer networks, with all of these information packets eventually arriving at their intended destination. 2. Black boxes, for lack of a better term, connect the various networks; these boxes are called 'gateways' and 'routers.' The gateways and routers do not retain information but merely provide access and flow for the packets being transmitted. 3. There is no global control of the Internet."

> "NGNs can be defined as networks with a packet-based architecture, facilitating the provision of existing and new/emerging services through a loosely coupled, open and converged communications infrastructure. The advent of NGNs is bringing forward a series of innovative opportunities but also a greater array of challenges, touching upon competition, interconnection agreements and new business models."[5]

Abusive discrimination in access to networks is usually characterised in telecoms as a monopoly problem, manifested where one or two ISPs have dominance typically in the "last mile" of access for end-users. ISPs can discriminate against all content, or against the particular content that they compete with, where they are vertically integrated. Hahn and Wallsten (2006) explain:

> "net neutrality has no widely accepted precise definition, but usually means that broadband service providers charge consumers only once for Internet access, don't favor one content provider over another, and don't charge content providers for sending information over broadband lines to end users."

Frieden, whose perspective is analytical and consumer-centric, reflects where regulators' perspectives need by law to be focused[6]. He summarises:

> "Network neutrality advocates worry that major ISPs have both the wherewithal and incentive to bifurcate the Internet into one medium increasingly prone to congestion and declining reliability and one offering superior performance and potential competitive advantages to users able and willing to pay, or affiliated with an ISP operating a major bitstream transmission network".

We agree that this is the focus of the problem: network owners with vertical integration into content or alliances have enhanced incentives to require content owners (who may also be consumers) to pay a toll to use the higher speed networks that they offer to end-users. In European debate, the issue has been dismissed by some – notably Currie (2006) – as an "American problem" caused by the abandonment of Local Loop Unbundling (LLU) regulation for broadband competition in the local access network. By contrast, the European Commission has proposed a more sophisticated approach in its review of the Regulatory Framework, adding interoperability and minimal service quality requirements to the interconnection requirements[7]. The i2010 High Level Group has stated:

> "The 'net neutrality' debate in the USA highlights operators' propensity to enter into preferential distribution arrangements with some content providers … [this] may be problematic and the issue needs to be subject to wider discussions."[8]

Also note that the OECD (OECD April 2007) acknowledged the concerns associated with anti-competitive conduct; the prospect of hindering access to information; and the privacy implications of monitoring the content that travels through ISP networks.

The debate regarding United States 'Net Neutrality' can be examined to identify what is useful in that debate for the European situation. Net Neutrality has been variously defined, most

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[5] See OECD (2006) "Next Generation Networks: Evolution and Policy Considerations", 3 October 2006 http://www.oecd.org/document/12/0,2340,en_2649_34223_37392780_1_1_1_1,00.html

[6] Frieden Rob (2006) Internet 3.0: Identifying Problems and Solutions to the Network Neutrality Debate at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=962181>http://papers.ssrn.com/sol3/papers.cfm?abstract_id=962181.

[7] See European Commission (2006) 'Staff Working Document', 28 June, at: http://ec.europa.eu/comm/avpolicy/reg/tvwf/modernisation/consultation_2005/index_en.htm, at section 6.4, NGN access to content

[8] i2010 High Level Group (2006) The challenges of convergence: draft discussion paper, at http://ec.europa.eu/information_society/eeurope/i2010/i2010_high_level_group/index_en.htm

prominently by regard to its forerunner "open access" by legal theorists Lemley and Lessig (2001), and the term 'Network Neutrality' was first used by Wu (2003). The classic regulatory action to prevent blocking of access was the decision, by the US Federal Communications Commission (FCC), to enforce non-discrimination against a small ISP which had been blocking Voice over Internet Protocol (VOIP) service (Madison River Communications)[9]. The suggestion is that the problem can be resolved by either introducing greater competition, as for instance in certain Western European nations under the Telecoms Framework 2002[10] (as proposed for amendment 2007), or closely policing conditions for vertically integrated service, such as VOIP. In the 29 December 2006 merger of AT&T and BellSouth, the merged company undertook various commitments not to block other companies' applications directed over the internet connection provided by the merged company. This consent was extracted by a majority in the FCC[11]. AT&T agreed to:

- follow the FCC's four Network Freedoms[12] for thirty months;
- apply network neutrality principles for its broadband ISP between subscribers and the first internet exchange point for a period of two years;
- BUT it expressly reserved the option not to apply network neutrality principles for its Internet Protocol Television ("IPTV") service, and to any service beyond the first Internet Exchange point.

Note from the description of the first Internet Exchange or 'handover' point that, though discrimination is typically characterised as behaviour by "last mile" consumer ISPs against content providers (CPs), it can equally be undertaken at peering points by third parties[13]. We note that such discrimination may be more easily detected by the end-user when it is conducted by its ISP, but a far more pernicious and potentially undetectable discrimination may occur at peering points. Conventional US economic arguments appear to be broadly negative to the concept of net neutrality, as we discuss in Section 2[14]. Net Neutrality has been the subject of legislative proposals in the Congress in 2006[15]. Werbach, Lehr and others are currently

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[9] Madison River Communications, LLC, Order, DA 05-543, 20 FCC Rcd 4295 (2005), available at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-05-543A1.pdf

[10] The telecoms framework consists of five Directives, implemented in Member States in 2003, and reviewed on a process that began in 2006 and may conclude in 2008: see http://ec.europa.eu/information_society/policy/ecomm/tomorrow/roadmap/index_en.htm

[11] See Freiden (2007), citing AT&T/Bell South (2006) and the dissent of the Chair of the FCC: "Importantly, however, while the Democrat Commissioners may have extracted concessions from AT&T, they in no way bind future Commission action. Specifically, a minority of Commissioners cannot alter Commission precedent or bind future Commission decisions, policies, actions, or rules … To the extent Commission action is required to effectuate these [concessions] as a policy going forward, we specifically do not support those aspects of the conditions and will oppose such policies going forward."

[12] Michael K. Powell (2004) February 8, Speech at Symposium on "The Digital Broadband Migration: Toward a Regulatory Regime for the Internet Age" held at the University of Colorado School of Law.

[13] See Clark (2006) and Sirbu (2007) for technical possibilities in network architecture.

[14] See Woroch 2004, Thierer 2004.

[15] Communications, Consumer's Choice, and Broadband Deployment Act of 2006, at: http://thomas.loc.gov/cgi-bin/bdquery/z?d109:SN02686:@@@L&summ2=m&

attempting to redefine NGN access to content in terms of interconnection and other inter-carrier requirements, rather than end-user centred policy[16].

We briefly introduce the types of discrimination that may occur, issues of QoS, user-generated and/or distributed content, and broadband supply and investment in the following sections.

1.2 Types of content discrimination

We suggest the following types of discrimination might constitute the type of "non-neutral" behaviour by ISPs that may be found to be harmful to consumer welfare: non-transparency and misleading advertising, "throttling" or blocking, charging, certain types of "walled gardens".

1.2.1 Transparency failures

ISPs may fail to tell customers and application developers which services they offer – i.e., estimated bandwidth, latency, etc. This is essential to certain applications, which cannot run with latency or which are blocked or filtered. Even where there is regulatory commitment to enforce NGN access to content, the evidential problem remains. Van Schewick[17] has recently suggested that the main problems currently lie in mobile networks, where VOIP is routinely degraded or blocked. Kocsis and De Bijl have proposed a game theoretic perspective to analyze such incentives[18], similar to the simple game mapped out in RAND's study for Ofcom in September 2006. The problem here is that certain users are breaching their terms of use but being insufficiently or non-transparently sanctioned, and certain programmes are being throttled but the same applies. Often a security justification[19] is used and is often unchallenged by regulators.

1.2.2 Blocking and traffic shaping

Blocking or "throttling" is the furthest deviation from neutrality. Some economists think it justified, but the basic problem is a distortion of competition between the blocked and unblocked companies. For example, a company serving online gaming content from South Korea may typically choose to do so via P2P networks, whereas an American CP might use a premium service sanctioned by the ISP of the end-user. Not only is the Korean CP discriminated against, but neither end-user nor CP may be aware of the nature of the problem (Greenberg and Veystel, 2006).

Blocking and other forms of traffic shaping is controversial because, under current network management, it is a blunt tool. For instance, all P2P traffic using a certain protocol may be blocked. P2P can respond by encrypting its traffic or otherwise spoofing, but this creates an "arms race" much like that found in security software responses to the threat of breaches. In fact, the claims of ISPs are that P2P traffic contains a high proportion of malware, spam and spyware, and therefore it is filtered in the end-user's interest and in conformity with the Terms of Use for end-users[20]. Many assertions are made about the implications of certain types of traffic, but

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[16] Work-in-progress papers presented in autumn 2006 at TPRC and Wharton Colloquia.

[17] Schewick, Barbara van (2005) "Towards an Economic Framework for Network Neutrality Regulation" paper presented at The 33rd Research Conference on Communication, Information and Internet Policy (TPRC 2005)

[18] Kocsis, Viktória and Paul W.J. de Bijl (2006) Network neutrality and the nature of competition between network operators, TILEC Working paper September 2006.

[19] P2P networks carry malware, spyware, spam and other unsolicited and potentially harmful content.

[20] See Clayton 2005, Brown 2007, Pfleeger 2007.

regulators have no basis for deciding if such assertions represent big or small problems. The ISP assertion that P2P traffic contains a high proportion of malware may be disingenuous. Email spam and web surfing are the vectors for malware, but the ISPs do not block such traffic. This is an example of how a baseline of traffic and usage would help the regulator to understand the importance of claims made by stakeholders.

The claim made is that networks cannot be upgraded successfully given the flood of P2P traffic. This is by no means a universally shared sentiment amongst ISPs and we note recent comments attributed to Matt Beal, BT Wholesale's chief technical officer: "It is up to us at the core of the network to make sure there is enough bandwidth".[21] He further stated BT's NGN would "put enough [bandwidth] volume out there … so we don't have to [traffic shape]" which is "quite Big Brother-ish". There is therefore no consensus as to the type and extent of traffic shaping and other forms of blocking and throttling P2P traffic. Where ISPs do not have effective Terms of Use, or do not enforce uniformly those current strategies in place to dissuade "unfair" use, two consequences can follow.

1. Users are summarily terminated or suspended – this can be conducted by any ISP and may well be justified. This practice and could be made more transparent.[22]
2. ISPs choose to filter P2P traffic – typically popular file-sharing programmes.

This creates confusion amongst users as to whether and how content is "throttled". Certain types of traffic that are highly valued by the end-user of the internet – and many content providers, including the BBC's new Interactive Media Player and AOL Time Warner Germany's movie downloading service – can be discriminated against in whole or in part by service providers that are not dominant. This is because they either have good competitive or good traffic management reasons to do so – it makes their networks safer and more efficient, making it complicated to work out when their discrimination is motivated by arguably less benevolent factors, like blocking the competition.

There can be motives to throttle content no matter what ISP is discussed. There is P2P traffic that may be highly valued by individual users but is network-impairing in the volumes in which it is transferred over current networks. Future networks may try to cap it more effectively, which can itself lead to an "arms race" between encrypted P2P content and attempts by ISPs to detect P2P traffic .

1.2.3 Termination fees for content providers

Since broadband ISPs have a termination monopoly or duopoly over the end-user, they can use that to charge termination fees to those who wish to get access to the user. This behaviour is familiar to the cable TV industry, where only large CPs can secure free or even profitable carriage, whereas smaller CPs with less contracting power are forced to pay the cable TV operator for access. The fear is that a similar model will be imposed on the internet, where only

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[21] Meyer David (2007) ZDnet – Thursday, April 12: BT says no to traffic shaping http://uk.news.yahoo.com/zdnet/20070412/ttc-bt-says-no-to-traffic-shaping-20a87fa.htm

[22] Freiden cites Code Monkey (2006): "What the ISPs don't tell the public is that there are no free-riders among the content companies. They pay handsomely for their bandwidth. In fact, they are the true bread and butter for the major telecoms and ISPs. The reason that this "Network Neutrality" controversy exists today is that ISPs don't want to admit that their whole business model is flawed. They don't want to admit to their home customers that they need to pay for metered bandwidth just like they pay for metered water and electricity." This is an argument that end-users should pay a greater proportion of the costs of network upgrade which we return to.

large CPs with sufficient negotiating power[23], and those with political influence to secure favourable carriage terms, will secure free carriage. The argument in Europe is particularly pernicious because public service broadcasting (PSB) occupies a position of strong bargaining power with legislatures and regulators. The argument can therefore be characterised as: will NGN access to content apply only to PSBs, or to other/all content providers? We consider a different set of CP preferential treatments below.

1.2.4 "Walled gardens" or preferred partners

Carriers can offer exclusive, preferential treatment to one application provider over others, creating a type of "walled garden" of preferred suppliers. This is less distorting than blocking, depending on the type of walled garden and the 'height of the walls'. We can differentiate "walled gardens"[24] from an open/interoperable access "commons"[25]. This has wider regulatory implications, involving the development of "gatekeepers" rather than open access models[26]. Take an example: Mobile users inhabit a much more personal and pervasive environment than fixed internet users[27]. Compared to fixed line internet access there are additional constraints on full openness. The mobile industry has developed hitherto on the basis that operators control the use of their networks and the devices which connect to them. For that reason, the initial content offerings of mobile providers have tended to be provided in a "walled garden", in which the customer experience is "guaranteed" by the operator and discriminatory pricing can be imposed on third-party content providers through their contracts with the mobile operator.

In a "walled garden", the number of CPs is effectively regulated by their relationship with an ISP. 'Walled gardens' may evolve so that access providers (both mobile and fixed) are likely to continue to offer content and services to their customers, bundled with BB access. These services are often provided with guaranteed QoS (e.g. IPTV services Sky On Demand or Homechoice). These services are not necessarily anti-competitive *if* the end user can access the

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[23] Note that many CPs, amongst them Google, pay for cached content servers provided by content delivery networks such as Akamai Inc. Opponents claim that services such as Akamai are 'not neutral'. We note that this argument is particular to large CPs – in this paper we consider the activities of all CPs. The fact that some choose to use caches does not necessarily affect the broad regulatory policy.

[24] A 'walled garden' is a type of IP content service offered without access to the wider internet: most mobile telephone networks provided walled gardens to their subscribers.

[25] This is a well-developed distinction discussed at length in our previous report for Ofcom (Marsden, 2006). By 'commons', we refer to an open space, with interoperable and publicly available standards, of which the World Wide Web is the archetype.

[26] Continuing the analogy with commons and walled gardens, one can imagine that a walled garden can be protected and entry or exit charges imposed. By contrast a commons is open access, with no controls. The walled garden gatekeeper is likely to be the owner of the garden – the operator. 'Walled gardens' have historically described content or services bundled by an access provider as a package with fixed or mobile internet access. The content is usually supplied under contract by content/services providers and presented to the end user by the access provider as a branded 'portal'. The content or service can be acquired from a third party in exchange for a direct payment. An agreement to share advertising revenue is an increasingly common model. The service offered by an access provider may restrict users to content only in that walled garden. In this case, the access provider is a gatekeeper (like Vodafone Live! when it first launched). Alternatively, the access provider may give users the freedom to access the wider internet and consume other content and services, including those which may compete with those in the portal. In this case, he is not a gatekeeper to the internet (like the BT Yahoo! model).

[27] As a hypothesis chosen in Section 3, we did not consider that – in the medium term – mesh networks would achieve critical commercial mass such that they would affect the regulatory decisions to 2011. This may be inaccurate, but certainly to date such networks have been isolated.

wider internet and choose to consume other content. The critical competition issues for NGNs are:

- Access providers who provide bundled services could be motivated to degrade content services or applications which compete with their own portal services;
- If they do this, they will not be motivated to tell their customers that the QoS for these services is inferior
- They could use this scenario to leverage payment from content and applications providers
- Access providers may agree preferential arrangements with some content or applications providers but not make the same terms available to others

It is clear that discrimination and other forms of quality control are exercisable in a manner which does not fully support open NGN access to content.

1.3 Quality of Service

There is an argument that the internet should not develop QoS, and that therefore no filtering of packets or increase in quality should be allowed[28]. As internet engineering has for many years pursued the goal of increased reliability, speed and higher bandwidth, this position is opposed by Clark (2007) and Crowcroft (2007). The current 'best effort' internet has flaws, as Yoo (2005) states:

> "TCP/IP routes packets anonymously on a 'first come, first served' and 'best efforts' basis. Thus, it is poorly suited to applications that are less tolerant of variations in throughput rates, such as streaming media and VOIP, and is biased against network-based security features that protect e-commerce and ward off viruses and spam."

Content charging relies on a type of QoS for the internet, enabling network providers to discriminate between packets, to offer better than 'best effort' quality.

The standards body for 3G mobile telephony, 3GPP, has been working since 2000 on a set of standards called IMS, for IP Multimedia Subsystem[29]. This is an operator-friendly environment intended to generate new revenue via deep packet inspection. Fixed-line carriers and equipment vendors have created the "IPsphere", a new set of standards for network intercession in IP application flows[30]. Both sets of standards support the ability to filter and censor by file type on the internet. This enables the carrier to discriminate, to decide which content to delay and which to permit to travel at normal speeds to the end-user. As Waclawsky puts it: "This is the emerging,

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[28] Wikipedia, Packet sniffer; available at: http://en.wikipedia.org/wiki/Packet_sniffer. "A packet sniffer (also known as a network analyzer or protocol analyzer or, for particular types of networks, an Ethernet sniffer or wireless sniffer) is computer software or computer hardware that can intercept and log traffic passing over a digital network or part of a network. As data streams travel back and forth over the network, the sniffer captures each packet and eventually decodes and analyzes its content according to the appropriate RFC or other specifications."

[29] See Waclawsky, J. (2005) 'IMS 101: What You Need to Know Now', at: http://www.bcr.com/carriers/public_networks/ims_101_what_need_know_now_2005061514.htm

[30] See IPSphere (2006) 'Creating a Commercially Sustainable Framework for IP Services Realizing Next Generation Revenues', IPsphere Forum Work Program Committee Version 1b.0, May, at: http://www.ipsphereforum.org/home/IPsphere_CommercialPrimerExec050806.pdf

consensus view: That IMS will let broadband industry vendors and operators put a control layer and a cash register over the internet and creatively charge for it."[31] Of course, that also can lead to a type of "arms race" as P2P networks encrypt all traffic to prevent inspection, in the same way that firewalls on Intranets were evaded using Port:80 and other techniques (Pfleeger and Pfleeger 2006).

Odlyzko and Levinson (2007) refute many of the arguments for fine-scaled charging which underlies the architecture of IMS, NGN and QoS. They note that:

> "Technology appears to be making fine-scale charging (as in tolls on roads that depend on time of day or even on current and anticipated levels of congestion) increasingly feasible. Standard economic theory supports such measures, and technology is being developed and deployed to implement them. But their spread is not very rapid, and prospects for the future are uncertain … the case for fine-scale charging is not unambiguous, and in many cases may be inappropriate."

We see no obligation to take any firm position on the issue. What is important in our discussion is the extent of such potential discrimination, and its justification. Freiden (2006) "accepts as necessary and proper many types of price and QoS discrimination" and attempts "an identification of best practices in "good" discrimination that should satisfy most network neutrality goals without creating disincentives that might dissuade ISPs from building the infrastructure needed." That is also our goal, in a specific European context.

1.4 Bandwidth Supply: Traffic shaping and content "throttling"

All network owners have incentives to stop traffic flowing over their networks that is low value, high volume and for which it is unfeasible to tax – notably user-generated and transmitted content. This content is very low-value to the network and, with many millions of users, under current market and technological conditions there is insufficient value to charge individual users. Content on limited bandwidth networks can "choke" the network capacity, especially at peak times of usage (daytime for business, evening for consumers). In a "best effort" environment without congestion charging[32], that content has insufficient disincentives to prevent its flourishing: for instance P2P traffic and its use by early-adopter high-volume users. ISPs can choose to filter P2P traffic of various kinds – typically it is unencrypted relatively crude versions of popular file-sharing programmes, such as BitTorrent which is used to provide upgrades to the most popular multiplayer online game *World of Warcraft*. Many assertions are made about the implications of certain types of traffic, but regulators currently have no basis for deciding if such assertions represent real problems[33].

There are also security considerations in blocking certain types of content. Spam is routinely filtered by consumer ISPs; and certain types of unencrypted P2P traffic is also allegedly "throttled", though given the lack of official monitoring, proof of this remains circumstantial[34]. The ISP assertion that P2P traffic contains a high proportion of malware may be correct or disingenuous. Email spam and web surfing are the vectors for malware, but the ISPs don't block such traffic. This is an example of how a baseline of traffic and usage would help the regulator to understand the importance of claims made by stakeholders.

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[31] Waclawsky (2005) supra.

[32] See Crowcroft (2007).

[33] Public remarks of discussion between UK and French regulators at ENST conference 29 May 2007 in Paris.

[34] See Williams, C. (2007) Virgin throttles national cable network. 8 May, The Register, at http://www.theregister.co.uk/2007/05/08/vigin_nationwide_throttling/

Certain types of P2P traffic are highly valued by the end-user of the internet – and many content providers, including the BBC's new Interactive Media Player[35] and AOL Time Warner Germany's In2Movies downloading service[36] – and are potentially discriminated against in whole or in part by ISPs that are not dominant. This is because they have both good competitive and good traffic-management reasons to do so – it makes their networks safer and more efficient, making it complicated to work out when their discrimination is motivated by less unarguably beneficial factors, like blocking the competition.

Some content providers (for example Google and Akamai) also invest in network infrastructure (called Content Delivery Networks or CDNs) that minimise the end-to-end bandwidth required of the carrier's network in order to improve the user experience, and consequently minimise the need for the carrier to invest in backbone and exchange capacity. The CDN stores ("caches") content within countries and even networks, in order to deliver the content more efficiently and quickly than if there were only one global server to deliver all content. There is a research question that may be considered: would the introduction of QoS and discrimination enhance or diminish the business case for such local storage that is not on the network? More research is required on this topic, as it may be that NGN content discrimination could begin an "arms race" for local storage solutions between ISPs and CDNs. It is clear that such a competition would require extra resources above and beyond entry into content markets, and the prospects for European content development should be considered in the light of such potential costs.

1.4.1 Supply and investment

Most existing UK home internet connections are already at broadband speed. As Figure 1 shows, there may be a developing supply–demand "arms race", as connection speed and application bandwidth continually drive each other higher (at least in urban high-density locations). This is obviously only one of several different potential outcomes. If networks and commercial content providers cannot monetise their respective parts of the value chain, network effects can reverse into a "vicious circle", in which neither content nor network can secure investment to provide service[37]. Instead, the inflexion points at which investment in the lagging element is needed to prime the next phase of disruptive growth can become crisis points. At this point, investments may be constrained and a "virtuous circle" of investment replaced by a vicious circle of under-investment. This is claimed by some ISPs as a justification for traffic management and price discrimination, two of the types of content discrimination we discuss in the following section.

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[35] See http://www.bbc.co.uk/imp/ and the Ofcom Consumer Survey (2007) http://www.ofcom.org.uk/research/tv/bbcmias/ondemand/bbc_ondemand/bbciplayersurvey/

[36] See Time Warner (2006) *Warner Bros. Home Entertainment Group and Arvato Mobile to Launch Revolutionary Digital Entertainment Distribution Platform*, 6 February at http://www.timewarner.com/corp/newsroom/pr/0,20812,1156926,00.html

[37] Odlyzko (2004) states that: "Lack of quality statistical data was a prime source of the way many investors and decision makers in competing operators misled themselves around 1999 by following the hearsay on growth and focussing on whacky measures of value, while underestimating the real cost drivers." Odlyzko (2004) "The many paradoxes of broadband" http://firstmonday.org/issues/issue8_9/odlyzko at Table 4.

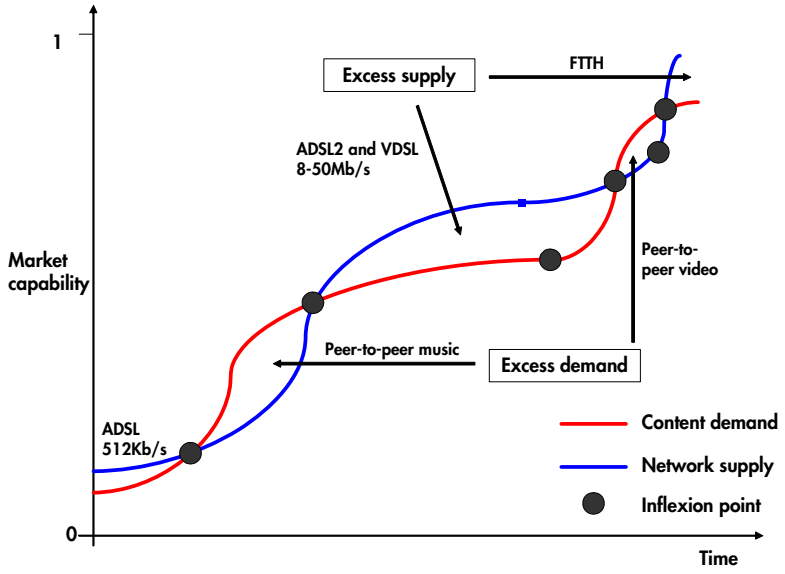

Figure 1: Possible Development of the Supply–Demand Curves for Broadband[38]

1.5 Consumer and User demands for content

1.5.1 Web2.0 and Service/Content Innovation

User-generated and distributed applications and services on the internet are seen as crucial to development of the broadband economy, increasing the utility and power of networked computing, especially the internet. As Commissioner Reding stated:

> "We are now living through a new disruptive phase of the Information Society. Some people call it Web2.0 or social networking. I can list some of the components: blogs, podcasts, wikis, social networking websites, search engines, auction websites, games, VoIP and peer-to-peer services. What is new about these uses of the Internet is that they exploit the Internet's connectivity to support people to network and to create content. This is a new paradigm in which users are co-producers of services."[39]

Web2.0, makes user-generated and distributed content central to consumers' internet experiences. This phenomenon has fundamental impacts on the value chain of affected industries[40]. Notable European examples are VOIP software Skype and the P2P client Kazaa. User experience with digital games and multimedia suggests that they are likely to drive

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[38] The vertical scale represents both supply and demand increases – one could suggest to 100Mb or Gigabit Ethernet for supply and some similar measure for demand (noting that demand does not equate to continuous peak usage). As the Figure is illustrative, the scales 0-1 are indicative. This is a curve that could tip back on itself where supply truly becomes ubiquitous and therefore demand collapses.

[39] See Reding, V. (2006) The Disruptive Force of Web2.0: how the new generation will define the future, SPEECH/06/773 at http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/06/773&format=PDF&aged=0&language=EN&guiLanguage=en

[40] See for example Wirtz, B.W. (2001) 'Reconfiguration of Value Chains in Converging Media and Communications Markets', Long Range Planning 34: 489–506.

innovation and adoption of Web2.0 and P2P services and markets (Marsden 2006). Ruthless competition in these markets results in highly volatile and "snowballing" investment decisions: for states seeking to attract such investment, there is more of a "winner-takes-all" pay-off from the entrepreneurial investment climate provided[41].

If innovation is typically both user-distributed and user-driven, the implications are that innovation is encouraged by interoperability and open access: in general, ensuring that content can be freely shared between those users. This view is in some conflict with content and network owners' need to be recompensed for their services and has led to an animated debate in the United States. Lemley and Lessig claim that innovation at the edge of the network is opposed by traditional media and network businesses, as it makes business cases based on controlling distribution bottlenecks redundant: where there is peer sharing, there is less opportunity for traditional bottlenecks and therefore control of revenues. However, the inverse applies also: without some means to secure revenues for the increased bandwidth necessary for Web2.0 type applications to flourish, do network operators have an incentive to upgrade? As Whitacre of AT&T famously stated:

> "The Internet can't be free in that sense, because we and the cable companies have made an investment and for a Google or Yahoo! or Vonage or anybody to expect to use these pipes [for] free is nuts!"[42]

The type of content described above is the most susceptible to discriminatory pricing and therefore forms a focus for the discussion of discrimination that follows. A goal of the European Commission is to encourage the development of European content providers to match the American success stories: "The creation of an open and competitive single market for online content is one of the key aims of the EU's i2010 initiative."[43] The European approach to "Content Online" is to be laid out in a Communication from the European Commission, expected in the autumn of 2007. The questions we explore here regard the barriers to entry for European content providers. Would content-sharing sites develop if discriminatory content charging was the state of the world? Furthermore, the network effects required to make content successful may only be possible because content sites do not initially seek to monetize content: monetization is enabled because the network effect created a critical mass of contributors and consumers. The "next" YouTube may face disincentives to achieve such growth.

1.5.2 The user as citizen and Universal Service Obligation (USO)

Many European citizens will want to use P2P services to share photographs, music and other user-generated content. A type of USO that is upgraded as broadband network speeds increase can ensure a minimal open internet layer is maintained. We do not in this paper take any position on whether the USO will be extended for NGNs, nor is it possible to do so in an environment where the future bandwidth supply/demand capabilities are so uncertain. However, we raise the issue – which is part of a current European Commission research project[44] – in order to emphasise that the debate is broader than the question of application of competition law, and encompasses societal needs and consumer rights. Users increasingly expect a level of unfiltered

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[41] See Katz, M. and Shapiro, C. (1986) 'Technology Adoption in the Presence of Network Externalities', Journal of Political Economy 94(4): 822–41.

[42] Business Week International Online Extra (2005) "At SBC, It's All About 'Scale and Scope'", 7 November, at: http://www.businessweek.com/@@n34h*IUQu7KtOwgA/magazine/content/05_45/b3958092.htm

[43] See http://ec.europa.eu/avpolicy/other_actions/content_online/index_en.htm

[44] See workshop at the Joint Research Centre in Seville, which discussed scenarios for USO, on 19 April 2007.

access to 'free' content on the Internet, and is it possible that this will be confirmed by a redefinition of the USO in the near future.

The alternative may be to consider the role that "mob" behaviour might play in Web2.0. The current example is the hack of the HD-DVD protection code and the subsequent "citizen action" to post that code everywhere on the Web after the hacker received a Cease and Desist order. We may expect to see more of this behaviour by 'netizens' as a digital form of civil disobedience by those who do not agree with a law or policy. Regulators (and their political equivalents) will not be able to ignore such problems, even if they do not reach the level of the Swedish "Pirate Party"[45]. Users whose access to Internet content is 'throttled' have reportedly 'flamed' or send abusive email to ISP owners.

1.6 Conclusion: A European approach to NGN access to content?

Our approach is of the "middle way" proposed by Atkinson and Weiser (2006), and Freiden (2006). It neither proposes an absolute ban on price discrimination where justified, nor an absolute prohibition on regulatory oversight. Instead it begins by asking which abuses are central to the problem in Europe. We have identified an immediate problem requiring regulatory oversight that is counter-intuitive: the immediate problem with NGN access to content may not be so much with the dominant SMP ISP, but with the smaller ISPs. It may be a disguised economic incentive problem that is first identified as a security issue. It may further impact relations between ISPs, in that those (typically smaller consumer) ISPs that are generating most spam and P2P traffic can adversely affect the security and traffic management of other networks, and cause particular problems at peering points.

There may therefore be a case for identifying the non-SMP operators as the current miscreants in NGN access-to-content policy. We suggested that widespread discriminatory behaviour can take place even where an ISP does not have SMP. Competition between ISPs is present in some metropolitan and suburban networks, but is limited by both geographical scale and feature-price scope[46]. Note that where only retail resellers use a broadband line from the incumbent, the degree of price and feature competition is very small given that wholesale prices and bit-rates are set by the incumbent. It is therefore an easy generalisation to claim greater broadband competition in Europe, when for infrastructure (where real investment is made and real innovation in service is possible) this may not be the case either currently or in the near-future (Van der Berg 2007).

We turn in Section 2 to the specific economic assessment.

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[45] See http://www2.piratpartiet.se/international/english

[46] Note that of Europe's 450m population, only a small proportion are in reach of an unbundled local telephone exchange, or an alternative high-speed infrastructure provider to the duopoly of cable and telecoms incumbents. See the EC Implementation Twelfth report of 29 March 2007 at http://ec.europa.eu/information_society/policy/ecomm/implementation_enforcement/annualreports/12threport/index_en.htm or the ECTA Regulatory Scorecard: http://www.ectaportal.com/en/upload/File/Broadband%20Scorecards/Q306/FINALBBScQ306.xls

CHAPTER 2 Economic analysis of discrimination

This section discusses the practices and forces that produce and limit economic discrimination and its desirable and undesirable characteristics. It also proposes some tentative policy conclusions and recommendations. The fundamental issue is whether strategic intermediation by service providers creates a substantial prospect of market failure. The answer depends on the services and contractual arrangements offered by service providers, of regulatory activities, on the extent and kind of market failure and on the likely future evolution of the system as a whole. We outline our approach and consider specific aspects of “good” and “bad” discrimination from the economic viewpoint.

The discussion includes a general treatment of discrimination from the economic perspective, because much of the policy discussion starts from the premise that discrimination is *ipso facto* bad. In fact, it may be good or bad, depending on both the issue addressed and the type of discrimination. It arises from the self-interested behaviour of economic actors whose actions may or may not also serve the public interest. Attempts to regulate or control them may have perverse consequences. Therefore, because stakeholders, market niches and policy options are so various, a general approach is appropriate.

Moreover, the policy rationales relating to content, Internet transport, pricing, access, etc. cover a wide gamut of economic phenomena. Lack of clarity regarding their differences leads participants to favour one-size-fits-all solutions on either the pro- or anti- extreme.

The intent of this section is to build an understanding of economic reasoning for readers to take forward into thinking about scenarios and policy options, rather than to present "the economists' judgement" on what's good or bad. In other words, the purpose is to help the reader understand *how* economists thinks about these issues, not *what* economists think. The section will have accomplished its purpose if the reader emerges with a sense of how deeply embedded is the 'rule of reason' approach to discrimination in both classical and cutting edge economics.

The application of these ideas is intended to operate both *ex post* (in interpreting market and regulatory developments) and *ex ante* (in thinking about future scenarios). There are a vast number of possible futures, and some way of organising them is necessary in order to avoid getting lost in ‘scenario space.’ While this paper does not present or analyse the scenarios developed with the aid of this analysis, it is worth noting that they were organised along two principle dimensions; service ‘cost’ – e.g. the cost of NGN services to users and the extent of ‘bundling’ or services into subscriptions. These are not design elements, but rather the outcomes of the interplay of the competitive, technical and regulatory forces described here.

2.1 Introduction

Discrimination and calls for its elimination in relation to NGN access to content are motivated by costs and benefits arising from market competition. To understand whether and when discrimination is "bad" it is necessary to consider how it arises and affects market efficiency (including consumer protection).

Discrimination can arise *ex ante* from market ground rules or as an *ex post* result of market interactions. This distinction between choice and consequence is the basis of competition policy, which considers:

- structure – observable division of the market among firms of different sizes, sectoral bases (e.g. vertical or horizontal integration) and other characteristics
- conduct – imperfectly observed strategic behaviour in choosing goods and services to offer, contract terms and conditions, innovation, bundling, ownership and other strategies
- performance – essentially unobservable efficiency with which the market identifies and reconciles user needs and preferences with supplier technologies and services.

Competition policy aims at improving market performance. This is complicated by factors outside the control of regulators or regulated firms. Thus conduct and structure must be considered when assessing the need for regulatory action. Specific conduct (e.g. discrimination) may amount to harmful anticompetitive behaviour or normal, legitimate and essential competition. Specific structures (e.g. dominance) may indicate a harmful cartel, success in past competition or efficient competition among firms with natural economies of scale.

Discrimination should not automatically be prohibited without clear evidence of pervasive harm. A blanket prohibition may not "catch" only harmful discrimination or may induce harmful responses. The problem of simple rules has long been recognised: mere monopoly or dominance is not illegal and even overt price-fixing is permitted under limited circumstances. Discrimination can be a pre-emptive, conscious and observable attempt by a firm with market power to "tilt the playing field" or the efficient result of economic competition. In the same way, policy can be an "up-front" rule or an analytically based "rule of reason" application linked to competition law or other economic regulation.

The economics of NGN access to content are grounded in a considerable body of industrial economic analysis. This section introduces some considerations from this literature to inform the political debate and lay out a framework for:

- describing economic discrimination
- distinguishing discriminatory activities and outcomes
- understanding which specific developments are likely to promote or inhibit discrimination
- evaluating the influence of discrimination on performance
- anticipating their impact on the harms and/or benefits of discrimination
- adding an economic basis for choosing between pre-commitment (fixed *ex ante* discrimination rules to which markets can adapt) and adaptation (basing regulatory decisions on changing market structure, conduct and performance).

This necessarily draws on a literature with which some readers may be unfamiliar. As a result, we attempt to balance a "reduced form" discussion of the main lines of argument for use in the

political discourse and structured references with more technical regulatory, industrial economics and game theory literatures that should inform the design and implementation of concrete policies and regulatory strategies.

Most of the economic literature reflects the mindset of competition regulation. This does not exclude either technological or societal regulation. On the contrary, these approaches interact and share common goals, differing primarily in relation to priorities and instruments. Competition is seen as an engine of broader development. The economic analysis is intended primarily as a contribution to the policy discourse rather than a solution to a specific regulatory problem.

In addition, the conventional analysis of discrimination in the context of quality competition takes a complete information perspective. Section 2.5 below adapts models of incomplete information to develop some simple insights about quality-based discrimination under asymmetric information, in the context of a more extended series of analyses.

2.2 Overview of the economic analysis

At heart, NGN access to content is mediated by rational and strategic commercial behaviour – this forms the positive part of the analysis. The normative part draws on variations on the theme of efficiency to evaluate progress or design optimal strategies for the "real world" of broadband service provision and its connected sectors.

Some discrimination is not only desirable but may be essential for markets to function at all. Other types may be distinctly undesirable (at least societally) and may even destabilise market equilibria. There is particular need to match market contexts and types of discrimination in vertically connected markets associated with broadband use, where discriminatory practices at one level may be undone or magnified at other levels.

The analysis supports policy by linking outcomes (which cannot be mandated) to key activities (which can at least be influenced) and indicators (used to trigger action). Analysis of discrimination must consider discriminatory *activities* and other parties' actions, which enable or limit discrimination or alter its efficiency consequences. This resonates with current "better regulation" preference for incentive-based, light-touch and adaptive controls that balance flexibility against credibility and take account of jurisdictional limits. Because discrimination can take many forms, the regulatory possibilities are quite diverse. The main proposals considered here are rules prohibiting price, connection or QoS discrimination in NGN access to content[47].

2.3 Economic discrimination

Discrimination occurs when customers face different prices for the same services (price discrimination) or receive different services for the same price (QoS or service discrimination). Discrimination along QoS or price lines converges to effective blocking at the high-discrimination endpoint (lowest quality, highest price).

This is not the same as differentiation (a menu of price-quality combinations offered transparently to all customers). However differentiation may be a way to achieve more subtle forms of discrimination (see 2.3.5).

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[47] Owen and Rosston (2003) Local Broadband Access: Primum Non Nocere or Primum Processi? A Property Rights Approach, Stanford Institute For Economic Policy Research working paper 02-37.

2.3.1 Activities promoting discrimination

Discriminatory activities reflect the potential (transitory) bottleneck character of access service providers. As described in Section 1, they include: price discrimination; access tiering (differentiated services); blocking (direct blocking by address or content type); service quality discrimination or degradation. There is nothing inherently wrong with this. Willingness to pay for QoS varies, as do costs of providing similar services to different users or uses. In addition (see 2.4.1), use of the broadband network is fraught with externalities and some discrimination is quite normal[48] e.g. for underwriting infrastructure provision and development, realising scope and scale economies and supporting socially-desirable universal access. But these same tools may be used to capture rents. It follows that neither blanket prohibition nor total freedom will preserve effective and fair competition and align market and societal interests.

In addition, these practices have evolved (and will continue to evolve) to reflect particular business models (e.g. client-server content provision), access structures (e.g. limited bypass) and norms; this argues for an evolutionary perspective to targeting.

2.3.2 Non-discrimination

Broadband markets offer combinations of infrastructure, services and applications to provide access to content and transactional services. Discrimination may be practised any of the complementary components – search, transport, downloading, payment, etc. Neutrality in providing one service may be offset by discrimination in another (e.g. neutral pricing with pre-filtered searching or "per-bit" pricing with discriminatory transport – resulting in failed downloads for some content or content providers). Hogendorn (2006) differentiates open access policies that prevent discrimination at the conduit (infrastructure and service) level from policies that prevent discrimination on the basis of content. Crowcroft (2007) refines this to distinguish neutrality in:

- connectivity (end-to-end, trans-layer non-discrimination or openness)
- performance (QoS (SLA) neutrality)
- service (openness to all new services)
- cross-layering (neutrality with regard to the construction and provision to users of combinations of services).

This level of detail is reflected in the "cost" dimension of the scenarios.

2.3.3 Bundling and vertical effects

Bundling of complementary services may be vertical (e.g. tying TCP/IP transport to specific infrastructure, application-orientated services such as web hosting and email, and/or access to specific content); horizontal (e.g. bundling content types, applications or platforms – as in converged communications); or both. This aspect forms the "bundling" dimension and captures the extent of complementarity, substitution and other drivers of discrimination internalised in market offerings.

In vertical markets some point in the value chain may be naturally or strategically captured and the monopolist or cartel is able to benefit from imposing conditions on other layers of the market. Such "choke points" – if unavoidable – are frequently subject to open-access, common-carrier or essential facilities regulation which has a strong flavour of neutrality: all those wishing to connect

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[48] Discrimination enters the analysis of public goods (Lindahl pricing), welfare-optimal pricing in the presence of e.g. joint costs (Ramsey pricing) and the internalisation of externalities (Pigovian pricing).

through the bottleneck should be treated in the same way. The positive core of the analysis looks at how bottlenecks are reinforced when the emergent monopolist introduces goods or services that enhance or are required for the enjoyment of other firms' offerings. This complementarity in NGN content access can lead to fragmentation (*de facto* groups of interoperating or bundled products, even if produced by apparently separate firms), non-existence or inefficiency of equilibrium and excessively slow or excessively fast innovation and technology uptake (Katz and Shapiro 1994).

A recent refinement looks on ISPs as offering a "platform" whose value derives from its role as essential intermediary between parties who may be differentiated (e.g. content providers and content users) or homogeneous (e.g. participants in massively multiplayer online role-playing games).

Competing platforms must be accepted by all "sides" to succeed (Rochet and Tirole 2004, Armstrong 2006). The two-sidedness of content or service provision differs from the *n*-sidedness of gaming. Figure 2 illustrates different market types.

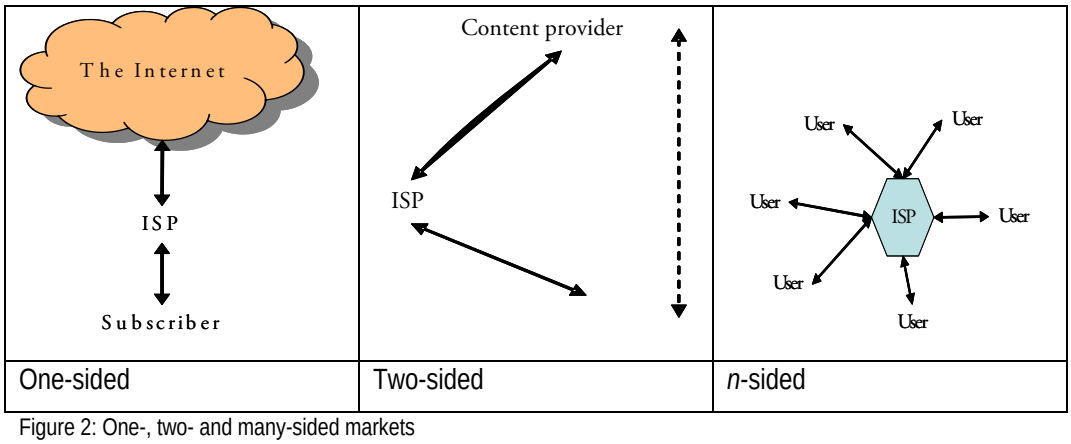

Figure 2: One-, two- and many-sided markets

Key implications are as follows.

- Usage or variable charges affect users' willingness to trade, and hence the net gain from potential interactions.
- Membership or fixed charges in turn determine users' presence on the platform.
- Detailed charge structures only matter if the users cannot negotiate away corresponding usage and membership externalities.
- The distinction between membership and use externalities is an essential factor differentiating gamers, content sharers, client-server content uses, etc.
- Profit-maximising ISPs may charge one customer group prices that are below marginal cost or even negative; such skewed pricing is prevalent, if not universal, in industries based on platform competition.

Over the years, courts have begun to treat such industries, notably payment/credit card systems, banks and newspapers, differently than those without two-sided competition.

2.3.4 Motives and drivers for discrimination

Discrimination may enhance welfare, profit and/or commercial rents to the discriminator alone. It can arise from:

- a deliberate and unilateral commercial strategy or policy by ISPs with more or less integration and market power
- equilibrium – the combined result of market forces and regulation
- long-term structural changes in integration, entry and exit, regulatory flight and the development of new (combined) goods and services.

2.3.5 Limits to the power of discrimination

Attempts to discriminate can be more or less effective depending on the basis for unequal treatment. An example is provided by price discrimination, though there are obvious analogies for blocking and QoS. It is conventional to distinguish between:

- First-degree (perfect) – each unit is sold at a different price.
- Second-degree – prices vary with the amount purchased.
- Third-degree – the market is segmented into distinct parts by location, time, type of traffic, etc. with different elasticities of demand.

Firms prefer first-degree discrimination, but are restricted by supply-side competition, arbitrage and regulation. Second-degree price discrimination (including "flex" plans where additional bandwidth can be purchased on the fly) is the most common, especially where resale can be limited and elasticity varies systematically with quantity (speed, bandwidth, etc.) demanded. Third-degree discrimination occurs when it becomes possible and profitable to discriminate among users or uses rather than usage levels. This increasingly takes the form of "bundled" subscriptions (tiered pricing/access based on something other than quantity) with "sweeteners" to match distinct user groups' characteristics and bind them by creating barriers to migration and arbitrage.

The power to discriminate is limited by rivals' and users' awareness. This informational barrier is manifest in tacit "fair use" limitations on "unlimited" broadband services or unpredictable (by the subscriber) variation in QoS as the combined result of subsequent subscription sales, investment by the SP and the telecom IP and the behaviour of other subscribers.

2.3.6 Factors limiting the extent or impact of discrimination

Because discrimination leaves some users (potentially) preferring others' combinations of services, quality and price, a range of factors can limit its extent or damaging effects. Consumers who become aware of and gain access to alternatives should opt for those most closely meeting their needs. This does not imply convergence to a one-size-fits-all solution, though interoperability concerns will likely ensure some similarity. The very inefficiency of "bad" discrimination proves that additional gains from trade could be captured by intermediaries providing information and other facilities to strengthen consumer search. A persuasive example is provided by the evolution of telephone pricing plans – especially mobile telephony with its lower technological barriers to migration. Tariff and subscription combinations show wide variation and relatively high churn (after number-portability obstacles were removed). This could indicate efficient matching of plans to subscriber tastes or a deliberate complexity to frustrate comparison, consumer search and thus blunt the force of competition.

Some gains from reducing bad discrimination can be realised by trades among users –resale or even unmonetised sharing of services or content. However, such arbitrage is likely to reflect short-term gain-sharing and take no account of the need to cover fixed costs or to provide incentives for future content creation and other forms of innovation. In brief, it can undercut "good" as well as "bad" discrimination. Where specific individual service providers discriminate, competitors may intervene to serve those excluded. Such "niche entry" can result in neutrality

across the market without necessarily imposing it on each provider. In multi-sided markets[49] the ability of even monopolistic platform providers to discriminate is limited to the external gains to users from connecting to each other. If users bargain effectively, they can reduce the surplus available to "divide and conquer" platform providers. Such bargaining can be particularly effective between single-homed and multi-homed users, providing that one side of the market (content providers, for example) is predominantly multi-homed, and thus the object of competition among platform providers.

Often those able to discriminate depend on e.g. telephone service providers whose services are both valued by customers in their own right and required for the enjoyment of services offered on discriminatory terms. Foreclosure by those offering such "one-way essential complements" can prevent discrimination (Chen and Nalebuff 2006). ISPs who discriminate may themselves provide one-way essential complements to end-users (even in two-way markets, where platform providers complement transactions between the two "sides" of the market). Discrimination is harder with two-way complements e.g. when ISPs are equally dependent on access to content or subscriber bases. Alternatively, platform providers' leverage can be weakened if complementarity is reduced e.g. by multi-homing. In general, intermediaries' power is determined by their dependencies. The ability of an ISP to discriminate can also be limited by bypass offerings from "upstream" infrastructure providers or downstream content providers. Finally, more overt forms of discrimination are addressed by consumer protection or antitrust policies.

The *profitability* of third-degree discrimination is reduced by adverse selection and moral hazard[50] among users whose characteristics and behaviour cannot be observed or controlled by the SP. A firm that attempts to discriminate among users with different preferences for and costs of service is caught between its imperfect ability to tell users apart and competition from other firms for (parts of) its user base. Service bundles intended for one group may attract another, so equilibrium offerings may provide products that are less attractive to one group than what the market would offer if ISPs could credibly identify them. For instance, a high-cost group may get its preferred bundle while a low-cost group is offered the best bundle that would not attract the high-cost group. If there are many low-cost users, however, a rival can profitably enter with a single package that attracts both groups. Such a neutral offer can never be sustained in equilibrium as a rival could then offer a profitable 'cream-skimming' service to attract only the low-cost users, leaving the "neutral" firm with a loss. In this case there is no equilibrium. The effect is reinforced when costs are endogenous (e.g. when unlimited services encourage users to download and interact more than they intended when signing up). These factors favouring or inhibiting discrimination apply even to welfare-enhancing discrimination and to discrimination by blocking or service degradation as well as by price and capacity.

Adverse selection is explicitly analysed – and the above assertions substantiated - in Section 2.5 below.

2.4 What is good and bad about discrimination

The normative analysis of market function is based on concrete criteria, a presumption that effective competition should promote them and an analysis of how specific markets can fail to produce efficient and equitable outcomes.

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[49] See Armstrong (2006), Caillaud and Julien (2003) and Rochet and Tirole (2003).

[50] Rothschild and Stiglitz (1976), Spence (1978).

2.4.1 Criteria or objectives: "What we would like markets to achieve"

Technical efficiency: Technically efficient outcomes minimise average cost (including intangible and social costs) of producing and allocating goods and services. If not, it would be possible to make more money or produce more. Network and interoperability effects can damage technical efficiency to the extent that they are not 'felt' by producers.

At the firm level such external costs are not taken into account. This is a particular problem for services produced using shared capital investment or essential inputs (e.g. signal transport) supplied on non-competitive terms that do not reflect opportunity cost. In the same way, if participation in a content-sharing or interactive network imposes costs or creates value for others, participation levels may not minimise cost or maximise value.

At sector level, technical efficiency is driven by displacement of high-cost firms by low-cost ones. Discrimination may impede this entry and exit, and in turn distort innovation and investment. A particular problem arises when discrimination affects the response of the market to scale and scope economies. In a "natural monopoly", a single large firm can serve the entire market at lower cost than a set of smaller competing firms. The cost advantages of the large firm come at the price of monopoly distortion. The broadband picture may be more mixed: with *diseconomies* of scale limiting the power of centralised, highly-integrated or comprehensive content and/or service providers. There may be advantages to diversity and "personalisation" for defined or emergent user communities. The organisational and service alignment that minimises costs may be impossible to predict in advance and thus be put at risk by inflexible institutional arrangements.

Allocational efficiency: Any change from an allocationally efficient outcome makes someone worse off. Gains from trade are normally maximised in competitive markets by free entry and informed consumer search and in smaller settings by bargaining and negotiation. Discrimination may deter entry or distort expected returns. Complex pricing and inappropriate or inflexible bundling may limit search. Offers may be (intentionally) hard to compare or to vary, services may only be available on a fixed, predefined or long-term basis and profile information about the match between consumer preferences and content and/or services may not be "portable". In addition, user groups coalesced around specific ISPs or types of content[51] may find it hard to switch suppliers. Rapid change and "lock-in" mean choice of suppliers should be based on expected future opportunities as well as current offerings. These expectations may be self-defeating (e.g. crowding in popular services) or myopic, leading to inefficient churn. Evidence from other public utility contexts[52] suggests a combination of excess volatility and excess inertia with strong "default bias". There is thus no guarantee that search *per se* will drive efficiency.

Dynamic efficiency: Dynamic efficiency refers to change in the direction of higher technological and allocational efficiency. At the firm level this is driven by the ability to monetise returns to innovation and investment. This can depart from efficiency if expansion creates market power (investing for market share rather than current profitability) or if consumer search favours novelty over improved utility. Improvements may have little or no market impact if they accrue mainly to inframarginal participants. Figure 3 illustrates this in a competitive market: product innovations or investments that shift demand from D_0 to D_1 will not attract firms, and cost-reducing innovations

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[51] The first is evidenced by e.g. Second Life communities, membership in social networks, etc. and the second by the formation of 'cliques' around specific artists or genres studied in the "economics of superstars" (Rosen 1981).

[52] See e.g. Brigham and Waterson (2003) "Strategic change in the market for domestic electricity in the UK" at: http://users.wbs.warwick.ac.uk/cms_attachment_handler.cfm?f=c9dd7acd-1396-4895-a8c6-f485f1db344f&t=strategic_change.pdf.

or investments that shift supply from S_0 to S_1 will not attract users. Improvements will not be undertaken without the ability to discriminate nor be signalled in market revenues.

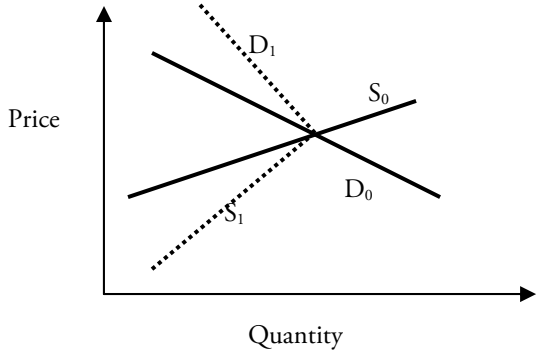

Figure 3: Inframarginal improvements that do not affect market outcomes

The analysis emphasises dynamic "innovation races", uptake of new services and emergence of new communities of interest beyond the firm level. We note that, while the debate over NGN content access considers whether upstream price discrimination will inhibit content provider innovation, it pays less attention to the possibility that such discrimination may stimulate both ISP and bypass innovation.

Consumer protection inefficiency

A fourth criterion is consumer protection in its own right. It is fostered by pre-emption (prohibiting practices likely to damage consumer interests) and facilitation (helping consumers to pursue their own interests on-line). One manifestation is universal access and quality, speed and affordability standards for service, content and other transactions, which provides broader societal benefits and directly feeds dynamic efficiency by encouraging the evolution of demand and the dissemination of innovative ways to express and meet preferences. A second manifestation is protection against informational asymmetries, fraud and other impediments to search and informed consent. Users should be able to learn about relevant aspects (from price through QoS) of available options – including the performance of their current provider. Where appropriate, they should be able to change providers with reasonable dispatch and at minimal cost. Finally, services should not compromise privacy or security interests without affording users meaningful choices. Beyond the obvious ethical concerns lie matters of simple practicality: such protections enable competition and limit incentives for firms to behave in opportunistic ways.

This does not mean that market outcomes are inherently efficient. Evidence from other contexts suggests that search can lead to suboptimal outcomes; a race to the bottom in quality, inappropriate transfer of risk to consumers and even a weakening of access. Such considerations become more important as economic and creative activity move on-line. Existing off-line consumer protection may require modification and on-line regulatory structures may need re-orientation away from increasingly-marginal business models (e.g. voice telephony and broadcast) or assumed levels of user awareness and skill inappropriate to broader participation on a global scale.

Linkages

These efficiencies are not separate: technical efficiency forms a necessary pre-condition for allocational efficiency; dynamic efficiency lays the basis for future technical and allocational efficiency; and the centrality of search puts consumer protection at the heart of all efficiency. In the standard model, purely competitive markets achieve all these efficiencies at once, but the assumptions required are stringent and not obviously met by NGN access to content.

2.4.2 Specific efficiency-based justifications for discrimination

There are some conditions under which efficiency requires discrimination. This section discusses three justifications (increased service levels, different gains from trade and cost-based pricing) and four factors favouring discrimination (heterogeneity, externalities, natural monopolies and public goods) that are most relevant to NGN access to content. First, we describe three justifications.

Discrimination often involves a net increase in service. This can pay a double dividend in investment and scale economies. It arises because a firm with significant market power but no power to discriminate maximises profit by restricting supply in order to bid up prices. If it can discriminate, it can achieve greater profits by serving different customers on different terms – the larger aggregate supply necessarily reduces allocational inefficiency. Gains from trade may be less fairly divided, but there are more of them, so this can be corrected by taxation, public service obligations and other regulatory tolls.

Discrimination was common (Hass 2007) in the history of the internet and is generally thought reasonable when specific service-use combinations offer different gains from trade. However they are divided, someone will not be treated equally even in the efficient outcome.

A traditional regulatory principle is cost-based prices. Where costs differ, prices and QoS should also differ even for a regulated monopoly provider. But the true "costs" of providing broadband service may include (for example) costs to subsidiaries, revenue impacts in complementary markets where the service provider has a stake in future demand growth or changes in essential input cost. If serving one class of users has a greater impact on future costs (e.g. via learning or capital expenditure), cost-based pricing would discriminate. Price regulation based on, for example, Efficient Components Pricing (ECPR[53]) could also depart from neutrality of the price and QoS combinations offered by a regulated dominant network operator at the infrastructure level or a dominant ISP at the service level.

Optimality typically involves asymmetric treatment in at least four situations (all of which apply in principle to the push, pull and interactive modes of broadband use).

Differences in demand elasticity and cost of provision.

The Ramsey pricing rule maximises social welfare subject to a minimum profit constraint. The price mark-up over cost[54] should vary inversely with the price elasticity of demand[55]. By extension, this discriminatory principle applies to differentiated suppliers of a common demand – in which case prices should vary with supply rather than demand elasticity.

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[53] The ECPR is an access pricing rule designed to achieve approximately Ramsey-optimal prices without the enormous informational requirements of strict Ramsey pricing. The ECPR covers the bottleneck firm for the private costs of allowing interconnection. Because it does not reflect social costs, however, it fails to perform efficiently in the presence of e.g. network or congestion externalities (Yanellis, 2006). Ramsey pricing is also challenged by convergence. Consider the current essentially one-way connection of long-distance and enhanced service providers to local loops. As e.g. VOIP increases the substitutability (and thus elasticity) of these services, the Ramsey principle requires higher access charges for both services.

[54] By extension, the same applies to the relation between variations in terms and conditions relating to connectivity and QoS and the elasticities of demand with respect to these service attributes

[55] Robinson 1933, Ramsey 1927, and Boiteux 1956, extended the rule to natural monopolies, which would lose money if forced to price output at marginal cost.

Externalities

Efficient pricing in the presence of externalities is Pigovian: the price of access or use should fully reflect its marginal *social* costs and benefits, including network and congestion effects. Failure to internalise use, user and service provision externalities via (discriminatory) negotiation or pricing can fragment the sector into separated "walled gardens" with loss of connectivity and possibly consumer protection. NGN access to content has already produced many new types of services, including search, data "mashups", collaborative content creation and multiplayer immersive environments. These have created many new externalities, briefly mentioned in Annex II.

Large fixed costs

With large fixed and low incremental costs, marginal cost (the allocationally efficient price) lies everywhere below average cost (the economically viable price), so allocationally efficient pricing will lead to withdrawal of capacity or attenuated investment. Fixed costs could be underwritten by subsidy (e.g. Universal Service funds or public broadcast license-funding but may most efficiently be covered by the internal subsidies of first-, second- or third-degree discrimination.

Public goods

A service is non-rivalrous if its uses are uncongested, associated with payments to fixed and shared infrastructure or (in a more extreme version) offer general positive externalities. It is not sensible to separate individuals' usage. Optimality involves that (common) level of provision at which the marginal cost of provision just matches the *combined* marginal value attached to it by all users. Optimal individual ("Lindahl") prices would lead each user to demand the common service level.

The analysis is complicated by real-world features [nonlinear pricing, complexity of choices, subscription and long-term contracting, "option value" and the demand for flexibility, "tipping" or "lock-in effects associated with service/content/use complementarities, network externalities and the inclusion of security and other services (Anderson 2001). But the fundamental implication remains: discrimination may be required for optimality, and fixed rules are likely to impede the search for appropriate and equitable forms of discrimination.

2.5 Discrimination with adverse selection and moral hazard

The literature analysing discrimination in the provision of online services has primarily taken a complete-information approach. This provides concrete results relating to economies of scope and scale, congestion externalities and related aspects of price and quality discrimination. But analyses of market developments and policy impacts should also reflect two central features of information markets. The first is asymmetries of information regarding the preferences of users and the quality of services. Efficient contracts should ideally match users and providers via suitably differentiated price/quality combinations – but the relevant information is not readily observed by all parties, and there are thus incentives to conceal or distort signals. The difficulty of observing relevant information is compounded by long-term contracting issues or switching costs; customers who discover that they have made a mistake may not be able to switch, and providers have only second-best tools at their disposal for limiting the consequences of a poor match.

This section develops some simple models of the implications of these informational issues. These are part of a more extensive treatment, described below.

2.5.1 Framework

The modelling begins with a one-sided monopoly provider of internet services to customers characterised by unobserved heterogeneity. Each customer is assumed to have a fixed demand for service quantity; demands are differentiated by (observed) quality. There are no externalities, and the analysis concentrates on discrimination associated with optimal contracting and the consequences of increased information about individual types.

The second model extends the first by introducing competition among service providers. Again, quality is observable and demands are fixed in quantitative terms.

For further development, a third model could revert to the monopoly situation in order to introduce quantity and congestion externalities on the service provider and/or other users. This analysis turns on the ability of firms to detect (and thus charge for) levels of use.

To complete the one-sided market analysis, a fourth model would introducing competition and network externalities into model 3.

A subsequent paper will develop models 3 and 4, together with three further aspects: implications for 'two-sided market' models; the role of reputations (experience-weighting) in implementing third-degree price discrimination; and 'walled garden' issues raised by varying patterns of connectivity (through which both content and congestion are shared).

2.5.2 Model 1: monopoly provision

An ISP offers services of variable quality q at a price p. Consumers are characterised by a 'preference for quality' parameter θ, and derive utility U(p,q:θ) from a contract (P,q), where U(p,q:θ) = θq-p. The proportion of users of type θ_i is denoted β_i. The firm's cost of supplying a vector of services of qualities $\underset{\sim}{q} = (q_1,...,q_k)$ is $C(\underset{\sim}{q})$, where $C(\underset{\sim}{0}) = 0$, $\frac{\partial C(\underset{\sim}{q})}{\partial q_i} > 0, \text{all i}$, $\frac{\partial^2 C(\underset{\sim}{q})}{\partial q_i \partial q_j} > 0, \text{all i, j}$ and $\lim_{q_i \to \infty} \frac{\partial C(\underset{\sim}{q})}{\partial q_i} = \infty, \text{all i}$.

Discussion The formulation is not as restrictive as might at first appear. Because the firm is a monopolist, the number of customers served is irrelevant, since either all or none of the users of a particular type will subscribe to the service. Moreover, the quality variable q could as easily stand for any explicitly contractible combination of service quality and utilisation that serves both to differentiate consumers and (potentially) service provider costs. We assume without loss of generality that k equals the number of distinct user types – if there are fewer contracts than user types, we can simply repeat the contract(s) involved. Note also that the difference in utility between customers of different types considering a common contract is $\Delta\theta q$ which is increasing in 'preference for quality' – this "Spence-Mirrlees condition" simplifies the analysis; it implies users cannot benefit from pretending to have different characteristics if they cannot benefit from imitating adjacent users.

Analysis

The monopolist's problem is to choose a set $(\underset{\sim}{p}, \underset{\sim}{q}) = (p_1, q_1; p_2, q_2; ... p_k, q_k)$ of contracts maximise profit. First, suppose that the monopolist can observe (verify) each user's type. He will then maximise profit subject only to a *participation* constraint – no user can be forced to subscribe, so the contract optimally chosen by a user of type θ_i must give at least as much utility as their 'outside option' which we take without loss of generality to be 0. The firm's problem is

$$\max_{(p_i,q_i)}\left[\sum_{i=1}^{k}\beta_i p_i - C(\mathbf{q})\right] \text{ subject to}$$
$$\theta_i q_i - p_i \geq 0 \text{ for each i (participation)}$$

The price charged for each service quality, p_i, is exactly the utility gained by the user: $p_i = \theta_i q_i$, so the optimum is characterised by the condition $\frac{\partial C}{\partial q_i} = \beta_i \theta_i$. To fix ideas, if the costs of providing different service levels are separable ($C(q) = \sum \beta_i C(q_i)$), the benchmark *first-best optimum* is given by setting quality for type i equal to the marginal cost of providing it: $q_i^0 = \frac{\partial C_i}{\partial q_i}$.

Now assume the service provider cannot observe user type (before contracting). This adds a second type of constraint: *incentive compatibility* – no user should prefer the contract intended for another. Formally, the monopolist's problem is now

$$\max_{(\mathbf{p},\mathbf{q})}\left[\sum_{i=1}^{k}\beta_i p_i - C(\mathbf{q})\right] \text{ subject to}$$
$$\theta_i q_i - p_i \geq 0 \text{ for each i (participation)}$$
$$\theta_i q_i - p_i \geq \theta_i q_j - p_j \text{ for each pair i, j (incentive compatibility)}$$

Using the Spence-Mirrlees property and assuming that user types are numbered in increasing preference order $\theta_1 < \theta_2 < \ldots < \theta_k$ we can easily verify that the participation constraint is only binding for the least-discriminating type (type 1), while for every other user, the only binding constraint is that he should just prefer his nominal contract to that intended for the next lower type:

$$\max_{(\mathbf{p},\mathbf{q})}\left[\sum_{i=1}^{k}\beta_i p_i - C(\mathbf{q})\right] \text{ subject to}$$
$$\theta_1 q_1 - p_1 \geq 0 \text{ (participation of type 1)}$$
$$\theta_i q_i - p_i \geq \theta_i q_{i-1} - p_{i-1} \text{ for each i} > 1 \text{ (incentive compatibility)}$$

These can be used to solve for prices as functions of quality:

$$p_1 = \theta_1 q_1$$
$$p_2 = \theta_2 q_2 - \theta_2 q_1 + p_1 = \theta_2 q_2 - \theta_2 q_1 + \theta_1 q_1$$
$$p_i = \theta_i q_i + (\theta_{i-1} - \theta_i) q_{i-1}$$

And the monopolists's problem and its solution are

$$\max_{(\mathbf{q})}\left[\sum_{i=1}^{k-1}\left[(\beta_i + \beta_{i+1})\theta_i - \beta_{i+1}\theta_{i+1}\right] q_i + \beta_k \theta_k q_k - C(\mathbf{q})\right]$$

First-order conditions are:

$$(\beta_i + \beta_{i+1})\theta_i - \beta_{i+1}\theta_{i+1} = \frac{\partial C_i(\mathbf{q}^*)}{\partial q_i}, \text{ all } i < k$$

$$\beta_k \theta_k = \frac{\partial C_k}{\partial q_k}$$

Note: $\theta_{i+1} > \theta_i \Rightarrow (\beta_i + \beta_{i+1})\theta_i - \beta_{i+1}\theta_{i+1} < \beta_i \theta_i \Rightarrow q_i^* < q_i^0$, all i < k

The first-order condition for users of type k is identical to the first-best solution, so their 'second-best' quality (q_k^*) is the same as their first-best (complete information) quality (q_k^0), albeit at a lower price $p_k^* = \theta_k q_k^* + \left(\theta_{k-1} - \theta_k\right) q_{k-1}^* < p_k^0 = \theta_k q_k^*$. By contrast, as noted above, all other user types get lower quality.

For concreteness, suppose that the cost function includes a (quadratic) quality-specific component and a (quadratic) component based on the aggregate provision ($\overline{q} = \sum \beta_i q_i$):

$$C(q) = \sum_i \left(\phi_a^i + \phi_b^i q_i + \frac{\phi_c^i}{2} \left(q_i\right)^2 \right) + \gamma_a + \gamma_b \overline{q} + \frac{\gamma_c}{2} \overline{q}^2, \text{ so}$$

$$\frac{\partial C(q)}{\partial \mathrm{q_i}} = \phi_b^i + \phi_c^i q_i + \gamma_b + \beta_i \gamma_c \overline{q}$$

Now define

$$\mathrm{r_i} = \begin{cases} \left(\beta_i + \beta_{i+1}\right)\theta_i - \beta_{i+1}\theta_{i+1} - \phi_b^i - \gamma_b \text{ if } i < k \\ \beta_k \theta_k - \phi_b^k - \gamma_b \text{ if } i = k \end{cases}$$

$$F = \gamma_c \sum_{j=1}^{k} \frac{\beta_j r_j}{\phi_c^j}$$

This leads to the following closed-form solution

$$q_i^* = \frac{r_i}{\phi_c^i} - \frac{F}{\phi_c^i \left[1 + F\right]}$$

Detailed computation of the profits earned establish that – under the assumptions of separable costs and fixed costs that do not vary by type – the firm's per-user profits increase with the preference parameter $_i$.

The following diagram shows the first- and second-best process and qualities for the simplest case, where k = 2 and the cost function is entirely separable.

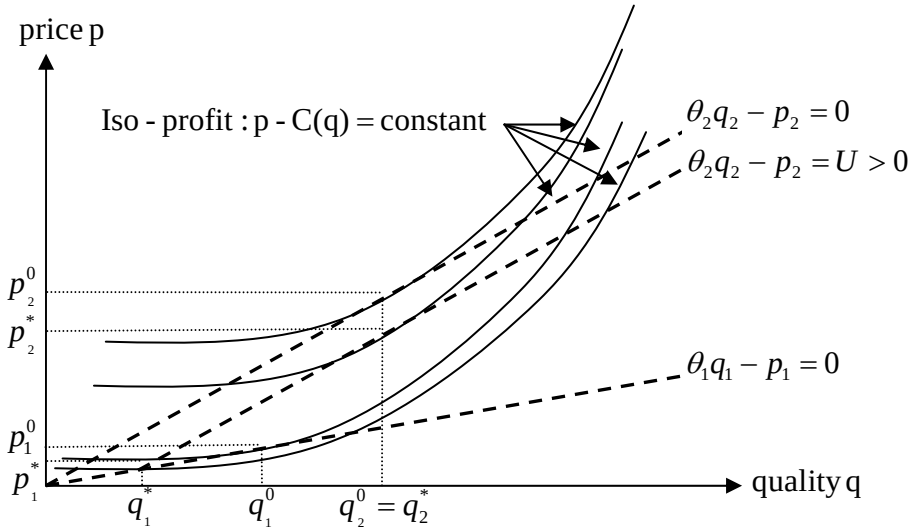


Figure 4: Monopoly separating equilibrium

In the above diagram, the curved lines are iso-profit lines increasing in the north-westerly direction, while the dashed straight lines are indifference curves increasing in the south-easterly direction. Thus the falling price for type 2 is necessary in order to keep them from switching to the type 1 contract. This reduces profit, but not by as much as offering a single policy.

A 'net neutrality' rule in this model would prevent the monopolist from offering differentiated price-quality combinations. In this case, the quality offered would be that provided in a world in which all users' preferences for quality were the same and equal to that of the 'lowest' type: $C'\left(q^{nn}\right) = \theta_1;\ p^{nn} = \theta_1 q^{nn}$. This reduces both producer and consumer surplus compared to either the first-best or the incomplete information 'non-neutral' arrangements derived above. It is also not robust to competition: rivals could easily enter with higher-quality (and higher-price) contracts that would attract higher-preference types. Indeed, as we show below, no 'pooling' contract which makes the same offer to different user types can survive in a competitive market. For this reason, we now turn to the analysis of competition.

2.5.3 Model 2: competition

The model above predicts that the combined force of profit- and utility-maximisation will lead to differentiated offerings. The key to the specific results is that users have no choice of providers. Depending on the level of fixed costs, the profits generated may attract entrants. In the above figure, for instance, any contract lying below the dashed line running through the type-2 contract will attract high-preference types. Because the original policy was a point of tangency, this will generate lower profits than those earned by the incumbent (especially for the special case of separable costs). But this entry may still be attractive for two reasons. First, if the entrant attracts only high-preference users, per-user profits will be higher than those earned by the incumbent. This, in turn, may mean that such rivals have lower capital costs, which can further enhance profits and quality. Second, the mere existence of positive profits for the incumbent means that an entrant could enter with a set of contracts lying just below those of the incumbent, but related by the same set of incentive compatibility constraints; the consumers will all switch, obtaining better outcomes. This process will only stop when the aggregate contract portfolio generates zero economic profit.

The position of this potential competitive equilibrium set of contracts depends on both fixed and joint costs of service provision. But two important observations can be made even at the present level of generality.

First, because the per-type profits vary with preferences, zero overall profit implies that some user types effectively subsidise others. For this reason,

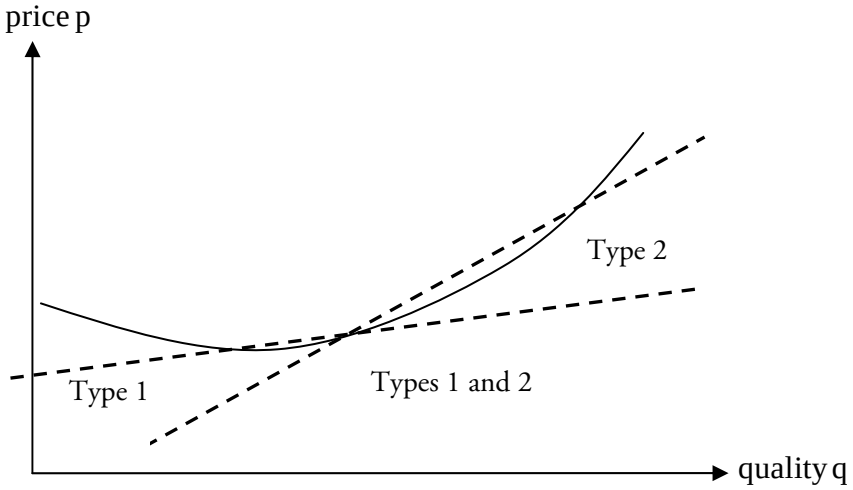
- Profitable types will be particularly attractive targets for cream-skimming entry,
- The equilibrium set of policies cannot be 'neutral' (one contract per provider)

Second, if the proportion and preference of high-preference types is high enough, an entrant can offer a single contract that attracts all types. Consider the simple two-type separable cost case given above. A pooled contract satisfies:

$$\theta_i \bar{q} - \bar{p} \geq \theta q_i - p_i, \text{ for all } i$$
$$\bar{p} - C(\bar{q}) \geq \sum_i [p_i - C(q_i)]$$

The viability of such entry reflects the dependence of profit on the proportions of different user types. The key observation is that the optimal contracts, being defined by the incentive compatibility conditions, have only minimal dependence on these proportions. In the no-subsidy case, where the zero-profit incumbent breaks even on each user type, the optimal contracts do not depend on the s at all. But the profit of a neutral 'pooling' entry does depend on these proportions, and increases with the proportions of higher-preference types. So as preference for quality increases, so do the opportunities for pooling entry.

But a non-discriminatory single contract cannot be an equilibrium. Due to convexity of the profit function, the indifference and iso-profit curves passing through such a contract have the following geometry:



Contracts below the dashed lines will attract the indicated types; contracts above the curved line will be profitable. Because the preferences of the user types are different, there will always be profitable entry against any pooled contract. In this case, if the population distribution allows profitable 'neutral' entry, there will be no market equilibrium, since any such contract is vulnerable to entry by a non-discriminatory rival by the above argument.

But this analysis makes unrealistic assumptions about consumer switching behaviour and provider reactions. In particular, entry by a 'cream-skimming' provider is only profitable on the assumption that the incumbent(s) will continue to serve low-preference users. If instead potential entrants assume that customers may not be able to switch or that incumbents will react (for instance by discontinuing unprofitable services), such entry will be deterred. In this case the

zero-profit separating contracts are in equilibrium provided only that they can withstand multi-contract entry.

The possibility of internal subsidies gives rise to a continuum of contract menus generating any given level of profits – in particular, there are a continuum of zero-profit menus satisfying users' participation and incentive compatibility constraints. Suppose entrants assume that incumbents will react in a credible manner by leaving the market, modifying contracts or discontinuing unprofitable ones in the face of entry in such a way as to leave themselves with nonnegative profits. In this case, the equilibrium will be the Pareto optimal zero-profit menu (unique under the Spence-Mirrlees condition).

2.5.4 Policy implications and extensions relating to this model

As mentioned above, a policy that restricts providers to a single offering will lead either to inefficiency or the churn that accompanies non-existence of equilibrium. Policies that facilitate consumer switching may, by improving the immediate profitability of cream-skimming entry, have a similar destabilising effect on optimal equilibria. On the other hand, such policies do prevent opportunistic or monopolistic market segmentation – in general the zero-profit equilibria identified in model 2 offer higher levels of aggregate welfare than the monopolistic equilibria of model 1. Moreover, such policies can have distributional effects; compared to the full-information (first-best) outcome, the incomplete-information equilibrium makes the highest-preference group financially better off (they get the same quality at a lower price, but reduces quality for all other user types. Thus societal objectives (including the development of demand with experience) may be improved by policies that allow users to credibly signal they types – for example by requiring providers to share usage information or allowing observable and transferable experience-rating of policies.

Further implications of the model can be derived from small extensions. The current setup assumes that the population is divided into a small number of discrete preference types *a priori*.

In general, user preferences may be distributed on a continuum. In this case, if there are quality-specific fixed costs, it is optimal to offer only a finite number of policies and the 'adverse selection' equilibria of the foregoing analysis develop a Hotelling character, in which the competing providers offer finite sets of strategically-placed contracts and respond to changing preferences by adjusting their offers. Note that in such models the diversity of services on offer may be far less than that of user preferences: for example, if consumer preferences θ are uniformly distributed along a fixed interval, and if consumers choose the (p, q) contract closest to their true preferences, two competing providers will tend to locate at the same places (the number of different contracts reflecting fixed costs and other sources of scale economies). With a larger number of providers, equilibrium may again fail to exist, as providers serving extreme 'niche' user groups can encroach on the services offered by mainstream providers without losing their 'core customers' – however, once they have converged, a small 'reconcentration' by any one of them will bring a large increase in exclusive market share.

Preferences relating to internet services are not only imperfectly matched with existing offers; they can change over time as a result of experience, technological change, etc. Moreover, initial information asymmetries can be resolved cover time as users and providers accumulate experience. This can produce 'hidden discrimination' where providers offer a single policy (or a reduced set of policies) and alter contract terms in response to user behaviour. This alteration can take the form of service degradation (essentially, offering some users reduced quality at the same price as before) or renegotiation (offering new contracts on a discriminatory basis). Such experience data are private to the user and their prior service provider and generally unavailable to new rivals. This can lead to accelerated churn, as users facing adverse changes in service

migrate to other providers in a continuing cycle. The results are reduced consumer and producer surplus on both sides of the market.

In addition, as mentioned in the introduction to this section, user preferences are not defined simply over price and quality. While the above model is adequate for situations where consumers have fixed usage levels, or where they bundle usage with other quality considerations without interactions, the situation changes when there are congestion externalities affecting other users (linked to the same or other providers) or externalities directly affecting providers. In such cases, analysis predicts patterns of 'clustering' to efficiently internalise such externalities. However, much depends on the policy context and commitment powers of the parties. If users have rational expectations about levels of service (congestion, effective bandwidth, integrity, etc.), the analysis predicts the formation of 'clubs' with an entry component reflecting the value of external impacts on other members. On the other hand, if users learn about the use patterns of others, or change their own behaviour in response to observed service quality, the potential for disequilibrium and inefficiency increases.

In particular, because models where consumers bear externalities produce very different results from those where providers bear the external costs (due to the information asymmetries between providers and users), policies making providers liable for quality-of-service commitments generate higher levels of investment (indeed, excess investment in some cases).

2.6 Policy conclusions

This analysis of the economic literature supports some preliminary conclusions.

- Regulatory costs often exceed benefits in effectively competitive and highly dynamic markets. The competitiveness and dynamism of markets involved in access to internet content benefit consumers, content owners and ISPs alike.
- Even ISPs with significant market power have to attract many complementary users. This limits incentives and power to discriminate (at least in the gross sense of blocking). Content is needed to attract subscribers and vice versa. So ISPs with significant power in one part of the market may be constrained by (potential) competition in other parts and thus unwilling or unable to engage in "bad" discrimination.

This implies that most abuses can be controlled by market forces and existing regulation. To deal with foreclosure and facilitate multi-sided competition, some (vertical) separation may be necessary. Where required, additional control can be imposed on, or via, essential facilities within existing licensing and regulatory structures. It is therefore useful to consider whether limits to vertical coordination and the "height" of walled garden protections should be developed from competition policy grounds.

As a general rule, economists largely agree that innovation in pricing, services and quality, etc. should be encouraged provided consumer protection and fair trading rules are used to ensure transparency and facilitate search, competition and arbitrage. Such freedom should encourage investment, increase efficient utilisation of existing capacity and underwrite content creation and Web2.0 innovation (both ISPs and end-users innovate and innovation can be inhibited by prices that are too low as well as too high). Finally, increasing the "width" of the infrastructure layer by social investment in fibre or spectrum liberalisation could ensure that discrimination is constrained by effective competition and efficiently prices specific services to subscriber groups.

These are not policy recommendations *per se*. The decisions required in relation to NGN access to content are not exclusively economic. The considerations discussed here form part of the policy discussion but do not pre-empt it. Additionally, many of the arguments made here are

subject to empirical verification. Inferring performance from observable market structure or conduct data is at best imperfect. Even defining the market boundaries generates vast amounts of empirical and theoretical analysis. This might be seen as a "second best" argument for a simple anti-discrimination rule. But the potential risks of such a pre-emptive standard are well-documented; and arguments and tools used to analyse other harmful predatory behaviour could be applied here. Indeed, the challenges posed by quality competition and degradation in the general competition policy arena[56] may be easier to address in respect of NGN access to content with the aid of, for example, technological QoS and related measures.

We now integrate the policy analysis and findings from Section 1 with this more theoretical analysis to produce conclusions in Section 3, which help to develop understanding of the potential outcomes from various options for regulatory policy.

[56] See for instance the literature on 'versioning' or 'crippleware' (Shapiro and Varian 1998).

CHAPTER 3 Conclusions: Regulating NGN access to content

3.1 Watch list for regulators

The main point that emerges from considering NGN access scenarios is the complexity and dynamism of market evolution. The availability and design of a suitable regulatory response must reflect this dynamism and also mutual reactions of regulators and market players. Therefore, legislation to entrench a particular regime for NGN access to content appears a premature response to the emerging environment. Instead, we propose that regulators equip themselves with the skills and evidence base to rapidly investigate potential problems of unjustified discrimination. Further, we note that the European legal basis for regulatory intervention, especially the Access and Interconnection Directive, provides a wider and better variety of regulatory tools to intervene than the current US situation (Scott 2007).

3.1.1 Detection and standing

Two specific issues in this "watch list" are detection and standing. Engineers appear unable to agree on whether QoS will be introduced in NGNs, as QoS is a very longstanding issue that has never been implemented with commercial success on the public internet. However, should it be introduced, the types of harmful discrimination that can result may be undetectable. Blocking, as discussed in Section 1, is relatively easy to spot. "Throttling" or choking bandwidth, even where unjustified, may be harder to spot and even harder to efficiently regulate. Indeed, it is a moot point whether unjustified discrimination short of blocking is useful to an ISP, as discrimination against a particular content type can (at least currently) be overcome by encryption, and in order for discrimination to create a business case, it needs to be effective in creating substantial incentives for content providers to pay a premium. To do so without incurring the interest of a concerned regulator may be hazardous.

Regulators can monitor both commercial transactions and traffic shaping by ISPs to detect potentially abusive discrimination. The question of legal standing for content providers under Directives is a technical legal question that we leave open in this project, but upon which there is a need for greater discussion in the European Regulators Group (ERG) and elsewhere.[57] The

[57] The ERG consulted in 2007 on NGN access, in ERG (2007) ERG Consultation Document on Regulatory Principles of NGA (ERG (07) 16 at http://www.erg.eu.int/doc/publications/consult_regprinc_nga/erg_cons_doc_on_reg_princ_of_nga.pdf

European Commission has asked in the ERG "if discussion should not be dealing with access to content issues".[58]

3.1.2 Regulators and own-initiative investigations

If content providers cannot formally make individual complaints to regulators, it may be that an independent investigation into potential discrimination can be made on the regulator's own initiative, depending on its constitutional and formal powers. While this is appropriate for a converged regulator such as UK Ofcom which regulates both content and carriage, it may not be the case in other European jurisdictions. Both the European Commission and ERG would be well-advised to consider the types of response regulators could make to such complaints if standing is found to be lacking. We caution that no matter what theoretical powers may exist, their usage in practice and the issue of forensic gathering of evidence may make the regulatory task very burdensome.

3.1.3 Security and regulatory governance of "converged" networks

Currently, not only is it not a requirement for ISPs to notify customers when they block vital P2P-distributed applications, the security reasons given are outside the remit of typical economic telecoms regulators. This governance gap has been highlighted to Ofcom at the most senior levels, and is partially overcome by the institutional arrangements in the European Commission. Where the security reasons given by ISPs for blocking P2P traffic, which carries malware and other harmful content, is typically the concern of the Ministry of the Interior (in the UK, the Home Office) and occasionally the Ministry of Trade and Industry, the regulator defers to these senior agencies and has little technically-specific knowledge of data security[59]. In Directorate General Information Society and Media (DG INFSO), the Unit that covers information security is at least in the same DG as the enforcement and policy units.

3.1.4 International coordination of regulatory research

Therefore, we suggest that the European NGN content problem is not a lack of regulatory tools per se, but potentially a lack of forensic skills to analyse the potential consumer harms that can be created by unjustified discrimination. This is in part a reflection of the complexity of the issue set, including security and internet-peering issues, as well as more traditional telecoms and content issues. It is important that governments consider where best the issue is regulated, by telecoms regulator or by ministry. Because NGN access to content raises a set of new issues for regulators, the necessary skill set needs to be acquired and developed in consultation with other national and international regulators, and the European Commission. We note in this regard the work of the OECD, the bilateral relations with the US, and the European Regulators Group Convergence working group[60].

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[58] http://erg.eu.int/doc/meeting/erg_06_80_19th_plenary_conclusions.pdf

[59] See Brown, I., Edwards L. and Marsden, C. (2006) Legal and institutional responses to Denial of Service Attacks, Communications Research Network/Department for Trade and Industry joint seminar on Spam/DDoS, 13 November, at http://www.communicationsresearch.net/events/article/default.aspx?objid=1464

[60] See European Regulators Group (2007) 07(01) Working Programme for 2007 at http://erg.eu.int/doc/work_progr_2007/erg_07_01_work_programme_2007.pdf at p7: "ERG will consider the processes of convergence and the development towards a multi-play communications market as a topic for 2007. Convergence also impacts the relationship between communications and broadcasting markets (mobile-TV). Access to content (i.e. issues in distribution and conditional access to content, not content regulation, which falls outside the scope of the framework), net-neutrality, interoperability, bundling of broadband services

3.2 Next Generation Networks and co-regulatory solutions

Our conclusions have one critical proviso: regulation to ensure any form of NGN access to content in Europe should have as light touch as possible, while maintaining effectiveness, based on two recourses:

- information regulation, to require service providers to inform consumers about the choices they are making when they sign up for a service
- intervention, to correct harmful and unjustified discrimination that is timely but evidence-based.

3.2.1 Reporting requirements

These two regulatory interventions do, however, require regulators to impose a reporting burden on service providers to provide transparency in their traffic-management practices. This reporting requirement could be provided in a co-regulatory forum, via codes of practice adoption by, for instance, the Internet Service Providers' Association (ISPA) in the UK and its counterparts in EuroISPA. We note that the danger of fragmentation and regulatory arbitrage is apparent here for two reasons: a type of "regulatory holiday" for ISPs in one country but not another is quite likely, and enforcement of NGN access to content may be highly divergent even under the current 2002 framework. Therefore the EC as well as Member States will need to monitor developments in this area closely, especially in view of its policies for ContentOnline and the wider Lisbon goals[61].

Based on the incomplete evidence thus far, we suggest that NGN access to content be primarily enforced via reporting requirements on network operators. This is a form which can be classed as co-regulation in which market actors and self-regulatory bodies maintain a constant dialogue with regulators and consumers. This is a preferable lighter-touch regime to those of government-funded regulation and non-regulation of European NGN access to content. A light-touch stable regime provides investors with a reasonable level of business certainty. Investors require some certainty that carriers will not cause unwelcome "surprises" that distort their business case. Proposals that user-generated Web2.0 video and computer games be charged on the basis of QoS can be included in such "surprises".

3.2.2 Entry barriers and marketing as "internet service"

Dominant and entrenched market actors in regulated "bottlenecks" play games with regulators in order to increase the sunk costs of market entry for other actors, and pass through costs to consumers and innovators. Very high entry barrier co-regulation and self-regulation can be as effective in curbing market entry as direct content regulation. By and large, the greater the levels of regulation, the more likely the market is to develop towards more closed and concentrated structures, for three reasons:

- larger companies are able to bear compliance costs much more easily than SMEs
- larger companies have the resources and lobbying power to seek to influence regulation in a positive direction
- large ISPs in a concentrated market may offload costs upstream onto content providers and developers, or downstream onto consumers.

(flat-rate, triple and quadruple play offers) and consumer protection issues could be successfully investigated by ERG WGs and PTs."

[61] See http://ec.europa.eu/avpolicy/other_actions/content_online/index_en.htm

Therefore any solution needs to take note of the potential for larger companies to "game" a co-regulatory scheme and create additional compliance costs for smaller companies (whether content or network operators, and the combination of sectors makes this a particularly complex regulatory "game").

A group of academics and engineers[62] have proposed rules on what can be called "internet" service. Those rules might be considered a form of transparency regulation. Essentially they claim that any service that differentiates between packets is breaching the end-to-end principles of the Internet Protocol and therefore should not be labelled as an "internet" service. They suggest legislative wording as follows:

> "Network providers that offer special features based on analyzing and identifying particular applications being conveyed by packet transmissions must not describe these services as "Internet" services. Any representation as to the speed or "bandwidth" of the Internet access shall be limited to the speed or bandwidth allocated to Internet access."[63]

We do not comment on this proposal, beyond suggesting that regulators will need to form a view of what access to the public internet is required in order to make effective conclusions on the future for USO during the course of 2007-8. We emphasise that this debate is likely to grow in complexity during that period, and urge regulators to conduct research in this area. Unfettered internet access of some type is a currently enjoyed "public good" for consumers, particularly in the use of Web2.0-type applications and services, and this public sphere is a regulatory policy of continued consideration.

3.3 Conclusions: Regulating for end-users and innovation

- An open content model tends towards Web2.0-type "public good" value and innovation concentrated in end-users rather than network operators and associated clusters of developers.
- While this is by no means the only model for internet-based and ICT-oriented innovation, it is a promising new approach which Commissioner Reding has suggested should be encouraged.
- At the margin, the choices made now about the regulation of these sectors can have an impact on this business model choice, and therefore end-user benefits.
- In sum, these conclusions support a light-touch regulatory regime involving reporting requirements and co-regulation, with as far as is possible, market-based, low-cost solutions.
- Regulatory monitoring of potential abuses, including strengthening investigatory capacity and transparency for end-users, is a solution which maintains maximum flexibility and policy choice, while ensuring that any abuses can be quickly detected and dealt with appropriately.
- Solutions may be international as well as local, and international coordination of best practice and knowledge through fora such as the ERG and OECD will enable national regulators to keep up with the technology "arms race".

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[62] One of the developers of the original Internet Protocol, which essentially defines the Internet, see Leiner et al (undated).

[63] Internet Platform for Innovation Act, suggested wording (2006) at http://www.dpsproject.com/legislation.html

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